



User's Guide

Volume 1

BASICS

September 17, 2004 3:55 pm

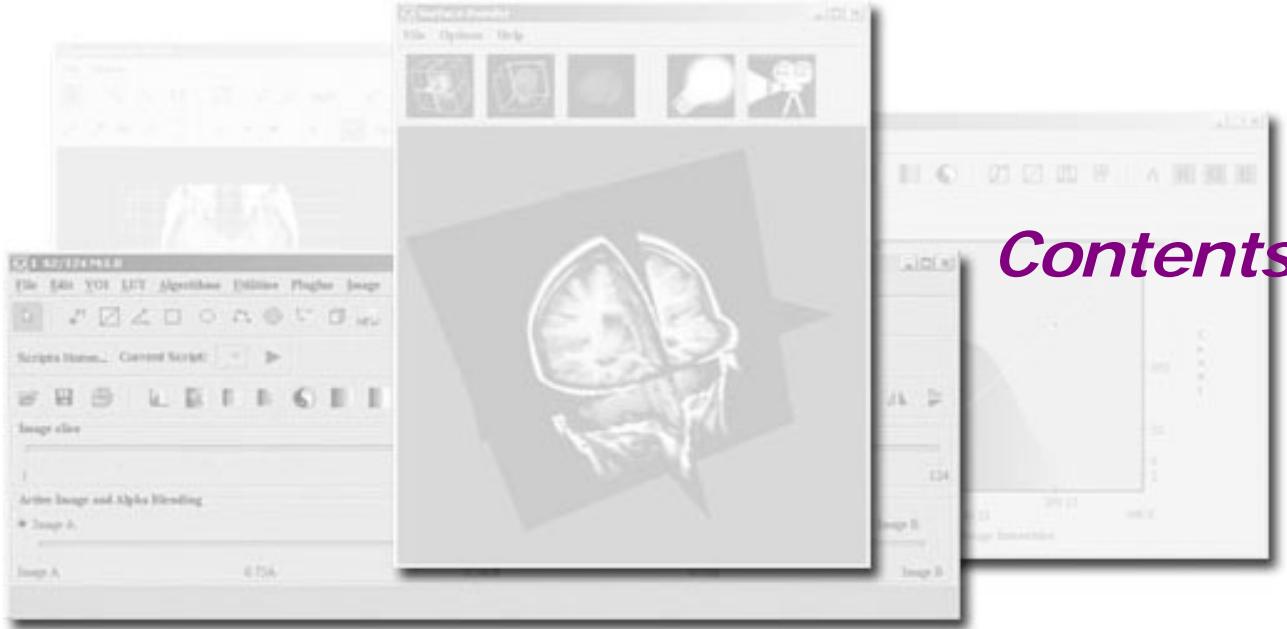
**National Institutes of Health
Center for Information Technology
Rockville, Maryland**

September 17, 2004 3:55 pm

Matthew McAullife, PhD mcmatt@exchange.nih.gov
301-594-2432
Building 12A, Room 2029
National Institutes of Health
Bethesda, Maryland 20892

If you find a bug, please send email to bug@mipav.cit.nih.gov. Frozen menus and JAVA exceptions dialogs are common signs. Please include as much information about what happened as you can. Please understand that we might need to get more information from you about what happened so we understand the problem.

If you have a feature idea, send an email to wishlist@mipav.cit.nih.gov.



Contents

List of Figures	xiii
List of Tables	xxvi
Preface	xxviii
Scope of this guide.....	xxviii
Who should use this guide.....	xxviii
Skills you need to perform tasks in MIPAV	xxix
How this guide is organized	xxix
<i>Volume 1, Basics</i>	xxix
<i>Volume 2, Algorithms</i>	xxxi
Where to find more information	xxxi
Conventions used in this guide.....	xxxii
Chapter 1	
Introducing MIPAV	1
Platform independence	2
Supported image types.....	3
Visualization of images	3
Volume of interest (VOI) segmentation and analysis	3
Extensibility with Java plug-ins	4

	Sampling of MIPAV's features	6
Chapter 2	Installing MIPAV.....	7
	Understanding the system requirements	8
	Installing MIPAV.....	9
	Subscribing to the MIPAV mailing list and searching the archive	11
	Viewing a list of enhancements and corrections made to MIPAV	14
	Upgrading MIPAV	15
	Removing MIPAV.....	15
Chapter 3	Getting Started Quickly with MIPAV.....	17
	Starting MIPAV	18
	Opening and loading image files.....	20
	<i>Opening image files</i>	24
	<i>Loading image files.....</i>	26
	Selecting views.....	29
	<i>Understanding image windows</i>	30
	<i>Moving images.....</i>	30
	<i>Displaying images using the default view.....</i>	30
	<i>Displaying images using the lightbox view</i>	31
	<i>Displaying images using the cine view.....</i>	33
	Adjusting magnification	34
	<i>Magnifying images.....</i>	34
	<i>Reducing the magnification level.....</i>	35
	<i>Restoring the original level of magnification</i>	36
	<i>Magnifying regions within images</i>	36
	<i>Increasing and decreasing the magnification level.....</i>	38
	<i>Showing intensity values through the magnification glass.....</i>	40
	Improving contrast, adding color, and creating negative images	41
	<i>Improving contrast on images quickly</i>	42
	<i>Using the Quick LUT icon</i>	42
	<i>Using the right mouse button</i>	43
	<i>Using the Adjust Window and Level icon</i>	43
	<i>Restoring images to their original appearance</i>	44
	<i>Applying color to images using predefined LUT</i>	48
	<i>Creating negatives of images</i>	50

Comparing images using alphablending.....	51
Creating new images	52
Delineating volumes of interest (VOIs)	55
<i>Generating contour VOIs using predefined shapes.....</i>	56
<i>Adding and moving boundary points on VOIs</i>	57
<i>Automatically adjusting contour boundaries</i>	59
Calculating VOI statistics.....	60
<i>Using VOI properties.....</i>	60
<i>Using the Statistics Generator.....</i>	64
<i>Selecting VOI and save options.....</i>	64
<i>Selecting statistics options</i>	66
<i>Reviewing the statistics</i>	68
Modifying image resolutions	70
Generating graphs (intensity profiles)	71
<i>Generating new graphs</i>	71
Saving graphs to a file	74
Printing images or graphs	75
Saving images	76
<i>Saving images in the same format.....</i>	76
<i>Saving images as RGB TIFF files.....</i>	77
<i>Saving images to MINC format</i>	77
<i>Saving images to another format or renaming images</i>	79
Customizing MIPAV	79
<i>Showing or hiding the splash screen on MIPAV start-up</i>	79
<i>Using platform-specific Open and Save dialog boxes.....</i>	81
<i>Showing and hiding toolbars</i>	82
<i>Turning the log mode on or off.....</i>	85
<i>Placing or removing MIPAV from debug mode.....</i>	86
<i>Placing MIPAV in debug mode.....</i>	87
<i>Developing and using plug-in programs</i>	91
Quitting MIPAV	91
Chapter 4	
Understanding Image Basics.....	93
Supported graphic file formats	93
<i>Vector file formats.....</i>	94
<i>Bitmap file formats</i>	94

Chapter 1	Three-dimensional (3D) graphic file formats.....	94
	Supported file formats	95
	<i>Adobe Photoshop (PSD) files.....</i>	97
	<i>Analyze files</i>	97
	<i>Audio Video Interleave (AVI) files</i>	98
	<i>Digital Imaging and Communications in Medicine (DICOM) files.....</i>	98
	<i>Graphics Interchange Format (GIF) files</i>	98
	<i>Joint Photographic Experts Group (JPEG/JFIF) files.....</i>	99
	<i>Microsoft Windows Bitmap (BMP) files</i>	99
	<i>Medical Image NetCDF (MINC) files.....</i>	100
	<i>MIPAV (LUT) files</i>	100
	<i>MIPAV (MTX) files.....</i>	100
	<i>MIPAV (PLT) files.....</i>	100
	<i>MIPAV (VOI) files</i>	100
	<i>PC Paintbrush (PCX) files.....</i>	100
	<i>PICT: TBD files.....</i>	101
	<i>Portable Network Graphic Format (PNG) files.....</i>	101
	<i>Raw data files</i>	101
	<i>Sun Raster (RS) files.....</i>	101
	<i>Tag Image File Format (TIFF) files</i>	102
	<i>Truevision Graphics Adapter (TGA) files.....</i>	102
	<i>X BitMap (XBM) files</i>	102
	<i>X PixMap (XPM) files</i>	103
	Understanding the MIPAV dimensionality and coordinate system.....	103
	Data types	104
	Headers.....	105
	Endianness	105
	Viewing and editing image attributes	106
	<i>Viewing image attributes</i>	106
	<i>Editing image attributes</i>	107
Chapter 5	Working with DICOM Images	113
	Understanding how MIPAV works with DICOM images	114
	Browsing DICOM images	115
	Sending and retrieving DICOM images	122

<i>Setting up the hosts table</i>	125
<i>Creating, editing, and deleting servers</i>	125
<i>Creating, editing, and deleting storage destination entries</i>	131
<i>Testing the connection</i>	135
<i>Posing queries and retrieving images</i>	137
<i>Receiving and sending image files</i>	141
<i>Displaying and editing DICOM tag information</i>	144
<i>Protecting patient privacy using Anonymize</i>	150
<i>Converting non-DICOM image files to DICOM format</i>	161
Chapter 6 Visualizing Images	168
<i>Displaying images using the default view</i>	171
<i>Magnifying and minifying images</i>	172
<i>Working with the magnifying glass</i>	176
<i>Viewing two images together</i>	179
<i>Comparing images using alphablending</i>	180
<i>Viewing portions of images using the checkerboard</i>	184
<i>Changing image brightness and contrast using LUTs</i>	186
<i>Applying predefined LUTs to images</i>	192
<i>Adjusting contrast using the transfer function</i>	195
<i>Displaying images using the animate view</i>	202
<i>Adjusting dataset display</i>	205
<i>Adjusting the brightness and contrast in images</i>	206
<i>Removing slices from image datasets</i>	206
<i>Playing a dataset "film"</i>	207
<i>Displaying images using the cine (movie) view</i>	211
<i>Displaying images using the lightbox view</i>	211
<i>Adjusting the lightbox view</i>	215
<i>Repainting (updating) the lightbox</i>	223
<i>Displaying images using the link to another image view</i>	226
<i>Displaying images using the triplanar view</i>	227
<i>Displaying image datasets in triplanar view</i>	227
<i>Designating new center points for image datasets</i>	227
<i>Aligning image datasets</i>	232
<i>Creating, modifying, and deleting point VOIs</i>	233
<i>Cropping images</i>	234
<i>Changing the intensity</i>	234

<i>Step 5, Commit</i>	290
<i>Creating a mask using the paint grow segmentation method</i>	291
Converting VOI contours to masks	294
Converting masks to VOI contours	295
Chapter 8 Analyzing Images	296
Calculating statistics for contoured VOIs.....	296
Calculating statistics on VOI groups	301
To calculate statistics on VOIs	303
To exclude a range of pixels from the calculations.....	307
To save the calculations to a specific file	309
To clear, or delete, all of the statistics on the Logging page..	310
To overwrite logging files automatically	310
Calculating the volume of masks	311
To calculate the volume of masks	311
To view the information.....	312
To save the information.....	313
Generating graphs	313
<i>Generating contour VOI graphs</i>	313
To generate 2D contour VOI graphs	313
To generate 3D contour VOI graphs	315
<i>Generating intensity graphs</i>	315
To generate 2D intensity graphs.....	316
To generate 3D intensity graphs of all slices in a dataset at a specific point	318
To generate 3D intensity graphs of specific areas.....	318
<i>Customizing the appearance of graphs</i>	319
To display or hide the points, or tick marks, on graphs	321
To display or hide the gridlines on graphs	322
To change the number of gridlines in graphs	323
To change the graph title and the labels on the X and Y axes	324
To change the background color of graphs	326
To reset graphs to their original background colors	328
<i>Changing the legends for functions</i>	328
To display or hide legends	328
<i>Changing the appearance of functions</i>	331
To display or hide functions	333
To change the color of functions	333
To reset functions to their original colors	334
<i>Modifying functions on graphs</i>	335
<i>Opening, saving, printing, and closing graphs</i>	335
To open previously saved graphs	336

To save contour VOI graphs or intensity graphs.....	336
To print contour VOI graphs or intensity graphs.....	337
To close graphs.....	337
Chapter 9 Changing Image Datasets Using MIPAV Utilities	338
Keeping a log of utilities applied to image datasets	340
Adding image margins	342
Copying images using the Clone command	344
Concatenating images	344
Converting image datasets to different data types	347
Converting 3D to 4D images or 4D to 3D images.....	350
Correcting image spacing.....	351
<i>Understanding the effect of contiguous planes on image scanning ..</i>	
352	
<i>Understanding how MIPAV solves this problem</i>	352
Cropping images.....	357
Removing 3D subset from 4D	360
Flipping images horizontally or vertically	362
Converting grayscale images to RGB images.....	363
Inserting slices into image datasets	364
Inverting the order of images (slices) in datasets	366
Masking images.....	366
Matching images.....	369
Adding noise to images.....	372
Randomizing image (slice) order	375
Rotating images.....	375
Removing images (slices) from datasets.....	378
Removing time volumes	380
Converting RGB datasets to grayscale datasets	382
Subsampling images	387
Swapping the third and fourth dimensions	390

Chapter 10	Using Scripts (Macros) in MIPAV.....	392
	Using scripts	392
	<i>Displaying the scripting toolbar</i>	393
	<i>Creating scripts</i>	393
	<i>Running scripts</i>	402
	<i>Editing and deleting scripts</i>	406
	Combining scripts and other programs	409
	<i>Using the mipav command</i>	409
	<i>Syntax of the mipav command</i>	409
	<i>Using Shell scripting to lessen typing</i>	412
Chapter 11	Developing Plug-in Programs.....	414
Appendix A	DICOM Conformance Statement	415
	MIPAV	415
	MIPAV DICOM communications interface	416
	Implementation model.....	416
	<i>Application data flow diagram</i>	417
	<i>Functional definitions of AEs</i>	418
	<i>Verification</i>	418
	<i>DICOM receiver (C-STORE SCP)</i>	418
	<i>DICOM query (C-FIND SCU)</i>	419
	<i>DICOM retrieve (C-MOVE SCU)</i>	420
	<i>DICOM sender (C-STORE SCU)</i>	421
	<i>Sequencing of real-world activities</i>	421
	<i>AE specifications</i>	421
	<i>MIPAV AE specification</i>	422
	<i>DICOM query (C-FIND SCU) AE specification</i>	423
	Association establishment policies.....	423
	Association initiation by real-world activity	424
	SOP specific conformance statement for SOP class study root query/retrieve information model C-FIND	425
	Association acceptance policy.....	426
	<i>DICOM retrieve (C-MOVE SCU) AE specification</i>	426
	Association establishment policies.....	426
	Association initiation by real-world activity	427
	Association acceptance policy.....	428
	<i>DICOM sender (storage SCU) AE specification</i>	428
	Association establishment policies.....	429
	Association initiation by real-world activity	429
	Association acceptance policy.....	431

<i>Verification (C-Echo SCP) AE specification</i>	431
Association establishment policies	432
Association initiation by real-world activity	432
Association Acceptance Policy	432
<i>DICOM image receiver (storage SCP) AE specification</i>	433
Association Establishment Policies	433
Association Initiation by Real-World Activity	434
Association Acceptance Policy	434
<i>Communications profiles</i>	435
Overview	435
<i>Supported communications stacks</i>	436
TCP/IP	436
Physical Media Supported	436
<i>Extensions, Specializations, and Privatizations</i>	436
Overview	436
MIPAV AE DICOM Services	436
<i>DICOM Configuration Details</i>	436
Overview	436
AE Title/Presentation Mapping	437
<i>Support of Extended Character Sets</i>	437
Overview	437
MIPAV ICOM AE	437
Technical Information	441
References	442
Glossary	443

List of Figures



Figure 1. MIPAV home page.....	5
Figure 2. Medical Image Processing, Analysis, and Visualization (MIPAV) home page	9
Figure 3. Downloading page.....	10
Figure 4. NIH LISTSERV page.....	12
Figure 5. How to subscribe to the MIPAV mailing list	13
Figure 6. The MIPAV window that appears after starting the program.....	19
Figure 7. Output window.....	19
Figure 8. Desktop showing the MIPAV window, the Output window, and multiple image windows.....	21
Figure 9. Open Image dialog box showing shortcuts.....	25
Figure 10. An image displayed in an image window.....	25
Figure 11. Expanded MIPAV window showing toolbars, image slider, and more menus after the first image is opened.....	26
Figure 12. Choose File Type dialog box.....	28
Figure 13. An image window	30
Figure 14. An image in an image window (default view)	31

Figure 15. An image dataset shown in a lightbox view	32
Figure 16. Lightbox Settings dialog box	33
Figure 17. Magnification icons are located on the image toolbar	34
Figure 18. Original image and magnified image achieved from click the Magnify Image icon once.....	35
Figure 19. Minified images that result from using the Minify Image icon.....	36
Figure 20. Magnified square region on an image	37
Figure 21. Magnification dialog box	37
Figure 22. Magnifying glass at different sizes.....	38
Figure 23. Magnification slider on the Magnification dialog box	39
Figure 24. Two different magnification levels in the same magnified region.....	40
Figure 25. An image window displaying intensity values for a magnified region in the image	41
Figure 26. Quick LUT icon on the image toolbar.....	42
Figure 27. Images before and after applying the Quick LUT icon.....	43
Figure 28. Level & Window dialog box	44
Figure 29. LUT menu in the MIPAV window	45
Figure 30. Histogram dialog box.....	46
Figure 31. Progress message that appears when the program is calculating the histogram.....	46
Figure 32. Lookup Table window.....	47
Figure 33. LUT toolbar	49
Figure 34. Image before and after inversion.....	50
Figure 35. MIPAV window showing the alphablending slider at the bottom of the window.....	51
Figure 36. Raw dialog box	52
Figure 37. Blank image	54

Figure 38. Contour icons on the VOI toolbar.....	56
Figure 39. Adding a point and adjusting the boundary of a rectangular VOI.....	58
Figure 40. Evolve Boundary dialog box	59
Figure 41. VOI Statistics dialog box	61
Figure 42. Output window showing statistics.....	62
Figure 43. Edit menu on the Output window	63
Figure 44. Save messages command on File menu in the Output window.....	64
Figure 45. Calculate Statistics on VOI Groups window	65
Figure 46. Statistics Options page.....	67
Figure 47. The Logging page in the Calculate Statistics on VOI Groups window ...	69
Figure 48. Options menu showing the Clear Log Window command.....	70
Figure 49. Image Attributions dialog box	70
Figure 50. Resolutions page in the Image Attributes dialog box	71
Figure 51. Right-clicking on selected VOI.....	72
Figure 52. Contour VOI Graph window	73
Figure 53. Intensity Graph window.....	73
Figure 54. Save dialog box.....	74
Figure 55. Print dialog box	75
Figure 56. Save dialog box.....	76
Figure 57. Attributes to Save (MINC) dialog box.....	78
Figure 58. Comparison of MINC and DICOM image orientation	78
Figure 59. MIPAV Options dialog box	80
Figure 60. MIPAV Options dialog box	82
Figure 61. VOI toolbar	83
Figure 62. Paint toolbar.....	83

Figure 63. Scripting toolbar	84
Figure 64. Image toolbar	84
Figure 65. Toolbars menu in the MIPAV window	85
Figure 66. Output window showing the Log page	86
Figure 67. Output window showing the Debug page	88
Figure 68. Memory Monitor dialog box.....	90
Figure 69. Change Java-Runtime Memory Allocation dialog box.....	91
Figure 70. Exit Confirmation dialog box.....	92
Figure 71. Example of 3D image (origin at top left)	104
Figure 72. Info dialog boxes for both DICOM and nonDICOM images	107
Figure 73. The Name page in the Image Attributes window	108
Figure 74. The Resolutions page in the Image Attributes dialog box.....	109
Figure 75. Orientations page in the Image Attributes dialog box.....	110
Figure 76. Dataset Origin page in the Image Attributes dialog box	111
Figure 77. Transform Matrix page in the Image Attributes dialog box	112
Figure 78. Communication pathways between MIPAV and DICOM	115
Figure 79. DICOM Browser command on the File menu (left) brings up the Choose Directory dialog box (right)	116
Figure 80. DICOM browser as it appears before parsing a directory.....	117
Figure 81. DICOM browser after parsing a directory and selecting an image to display	118
Figure 82. Set AVI Options dialog box.....	121
Figure 83. Choose Type of AVI File dialog box.....	121
Figure 84. Quicktime movie—one of the eight file formats for making movies from DICOM images	122
Figure 85. The four pages in the DICOM Communication Panel dialog box.....	124
Figure 86. Hosts page in the DICOM Communication Panel dialog box.....	126

Figure 87. The Help page in the DICOM Communications Panel dialog box.....	128
Figure 88. Create Server dialog box.....	129
Figure 89. Edit Server dialog box.....	130
Figure 90. Confirm Delete message	130
Figure 91. Default server in the Servers panel on the Hosts page	131
Figure 92. Storage Destination panel.....	132
Figure 93. Create Storage Destination dialog box	132
Figure 94. Edit Storage Destination dialog box.....	133
Figure 95. Confirm Delete message	134
Figure 96. Error message in the Send status panel on the Send page.....	136
Figure 97. QR Client page in the DICOM Communication Panel dialog box.....	138
Figure 98. DICOM Receiver On/Off command on the File menu in the MIPAV window.....	141
Figure 99. Send page in the DICOM Communications Panel dialog box.....	142
Figure 100. Image with DICOM overlay	144
Figure 101. DICOM Overlay Options dialog box.....	145
Figure 102. Select DICOM Tag for Overlay dialog box.....	147
Figure 103. Selected DICOM tags on buttons in the panel you chose.....	148
Figure 104. Attributes > View header commands on the Image menu in the MIPAV window.....	149
Figure 105. Info dialog box (DICOM)	149
Figure 106. Edit Tag dialog box for MR acquisition type tag	150
Figure 107. Anonymize sensitive info dialog box.....	151
Figure 108. Confirm for Anonymize message.....	152
Figure 109. Anonymize DICOM Directory command on the File menu in the MIPAV window.....	152
Figure 110. Directory page in the Anonymize DICOM Directory window	153

Figure 111. New directory command on the File menu in the Anonymize DICOM window	154
Figure 112. Choose Directory dialog box	155
Figure 113. Select Destination Directory dialog box	157
Figure 114. Tag Options page in the Anonymize DICOM Directory window	158
Figure 115. The Logging page in the Anonymize DICOM Directory window listing processing messages and MIPAV removes tags	160
Figure 116. Required page in the Attributes to Save dialog box	162
Figure 117. Patient page in the Attributes to Save dialog box.....	163
Figure 118. Study page in the Attributes to Save dialog box.....	164
Figure 119. Series page in the Attributes to Save dialog box	165
Figure 120. Save Range of Slices dialog box	167
Figure 121. Types of views as shown on the Image > Views menu	169
Figure 122. Image window showing the default view for a 2D image	171
Figure 123. Image window showing (A) a 2D image, or slice, and (B) an image dataset that has more than two dimensions.	172
Figure 124. MIPAV window showing image slice slider and slice buttons and lightbox icon	172
Figure 125. Zoom commands on the Image menu.....	173
Figure 126. Custom Magnification dialog box	175
Figure 127. Magnified region.....	177
Figure 128. Magnification Settings dialog box.....	178
Figure 129. Magnified region showing intensities	179
Figure 130. MIPAV window showing Image A and Image B slider.....	180
Figure 131. MIPAV window showing Active image and alphablending slider	183
Figure 132. Checkerboard Pattern dialog box.....	185

Figure 133. Examples of the checkerboard pattern applied to two loaded images	186
Figure 134. An image before and after applying Quick LUT	187
Figure 135. Histogram dialog box	188
Figure 136. Look-up Table window	189
Figure 137. Look-up Table window showing Image A and B histograms.....	191
Figure 138. Change Number of Colors dialog box	192
Figure 139. LUT toolbar	193
Figure 140. CT Presets dialog box.....	194
Figure 141. An image before and after modifying the transfer function	197
Figure 142. Open and Save commands in the File menu.....	198
Figure 143. Save dialog box	198
Figure 144. Save dialog box	199
Figure 145. Open dialog box.....	200
Figure 146. Threshold dialog box.....	201
Figure 147. Animate Parameters dialog box	203
Figure 148. Animate progress message.....	203
Figure 149. Image window shown in the Animate view	204
Figure 150. Brightness/Contrast dialog box	206
Figure 151. Slice number in the read-only box beside the Frame Number slider in the Animate window.....	207
Figure 152. Choose Type of AVI File dialog box.....	209
Figure 153. Choose File Type dialog box.....	209
Figure 154. Save Range of Slices dialog box.....	210
Figure 155. Image window showing the lightbox view	213
Figure 156. Lightbox view after increasing the number of rows and columns that appear in the window	215

Figure 157. Lightbox Settings dialog box	216
Figure 158. Grid size box	217
Figure 159. Save Settings command on the Options menu in the Lightbox Settings dialog box.....	218
Figure 160. Grid and frame border	218
Figure 161. Frame border size box	219
Figure 162. Background color and border color bars	219
Figure 163. Swatches page in the Pick Background Color dialog box	220
Figure 164. HSB page in the Pick Background Color dialog box.....	221
Figure 165. RGB page in the Pick Background Color dialog box.....	221
Figure 166. Magnification dialog box.....	222
Figure 167. Some of the display options available in lightbox view: (A) original lightbox view (image on the left) and (B) changed lightbox view (image on the right).....	225
Figure 168. Lightbox Close message	225
Figure 169. Image Frame Linker dialog box	226
Figure 170. Image window showing the triplanar view	228
Figure 171. Apply Transformation dialog box showing choices in the Interpolation list.....	231
Figure 172. Using the alignment tool in triplanar view	232
Figure 173. Image A, Image B, and Image B loaded into Image A	235
Figure 174. Show Axes command on the Options menu in the Triplanar-Dual window	236
Figure 175. Triplanar-Dual window	238
Figure 176. Closed angle that appears on each of the images.....	242
Figure 177. Changing the angle by dragging the arrow on the thin line	243
Figure 178. Crop Image dialog box.....	245

Figure 179. Painting an area on images in the triplanar-dual view affects images in the default image view	247
Figure 180. Paint Opacity dialog box	248
Figure 181. Output window after calculating the volume of paint.....	248
Figure 182. Paint Grow dialog box	249
Figure 183. Height Surface window	251
Figure 184. Manipulating the plotted image in the Height Surface window	252
Figure 185. Automatically generated contour.....	257
Figure 186. VOI with straight line.....	259
Figure 187. Example of a 3D rectangular VOI	260
Figure 188. Ellipsoidal VOI	261
Figure 189. Polyline VOI (A) and closed polygon VOI (B)	263
Figure 190. VOI Statistics dialog box	266
Figure 191. Examples of a bounding box.....	267
Figure 192. VOI trim parameter dialog box	269
Figure 193. Boundary or blended check box in the VOI Statistics dialog	272
Figure 194. Undo VOI, Cut VOI, Copy VOI, and Paste VOI commands on the Edit menu in the MIPAV window	274
Figure 195. Delete command on the pop-up menu.....	276
Figure 196. Image with (A) a painted region and (B) the resulting mask	278
Figure 197. Paint toolbar	279
Figure 198. Desired Paint Intensity dialog box.....	281
Figure 199. Swatches page in the Pick Paint Color dialog box	283
Figure 200. The HSB page in the Pick Paint Color dialog box	284
Figure 201. Munsell color wheel (left) and color strip (right)	285
Figure 202. RGB page in the Pick Paint Color dialog box	287

Figure 203. Paint Opacity dialog box.....	288
Figure 204. Images produced from using the commit icons.....	291
Figure 205. Paint Grow dialog box.....	292
Figure 206. Contoured VOI.....	297
Figure 207. VOI Statistics dialog box.....	298
Figure 208. Data page in the Output window showing statistics.....	300
Figure 209. VOI Selection page in the Calculate Statistics on VOI groups window ... 302	
Figure 210. Joined VOIs	304
Figure 211. Sending the joined VOIs to the VOI group list on the right.....	305
Figure 212. Statistics Option page in the Calculate Statistics on VOI Groups window 306	
Figure 213. Logging page in the Calculate Statistics on VOI Groups window	308
Figure 214. File Exists message.....	310
Figure 215. Overwrite file automatically command on the Options menu	311
Figure 216. Data page in the Output window (left) listing the region grow and volume information from the painted voxels in the image (right)	312
Figure 217. Save messages command on the File menu in the Output window	313
Figure 218. Contour VOI Graph window	314
Figure 219. Intensity Graph window.....	317
Figure 220. Point VOI	318
Figure 221. The Graph page of the Modify Graph dialog box.....	320
Figure 222. Displaying or hiding the gridlines and tick marks on the graph.....	323
Figure 223. Number of <i>X</i> -axis and <i>Y</i> -axis gridlines.....	324
Figure 224. Title, <i>X</i> -axis label, and <i>Y</i> -axis label boxes in the Modify Graph dialog box.....	325
Figure 225. Changed title and axes labels in the Intensity Graph window	326

Figure 226. Change background color button	326
Figure 227. Pick Background Color dialog box.....	327
Figure 228. Changed background color for the graph.....	327
Figure 229. Legend page of the Modify Graph dialog box.....	329
Figure 230. Legend at the upper right of the graph.....	330
Figure 231. Functions page in the Modify Graph window.....	331
Figure 232. Points displayed on a function whose color changed from red to blue ...	332
Figure 233. Fitted Functions page in the Modify Graph dialog box.....	335
Figure 234. File menu in the graph windows showing the Open Graph, Save Graph, Print Graph, and Close Graph commands.....	336
Figure 235. Save dialog box for saving contour VOI graphs or intensity graphs..	337
Figure 236. MIPAV Options dialog box showing Log mode selected.....	341
Figure 237. Add Image Border dialog box	343
Figure 238. Concatenate Images dialog box	345
Figure 239. The MIPAV window after concatenating datasets to generate 3D or 4D datasets	346
Figure 240. Convert Image Type dialog box	348
Figure 241. Convert from 3D to 4D dialog box	351
Figure 242. Views of the Header dialog box showing the tags listed under (A) Essential Image Information and (B) the DICOM tags in a later section of the header.	355
Figure 243. Choose File Type dialog box	356
Figure 244. Message received when image spacing is already correct.....	357
Figure 245. Contouring the area that should remain in the cropped image	358
Figure 246. Crop dialog box	359
Figure 247. Extract 3D Subset dialog box	361
Figure 248. Original image and image flipped horizontally and vertically.....	362

Figure 249. Concatenate -> RGB dialog box.....	364
Figure 250. Insert Slice dialog box.....	365
Figure 251. Interior and exterior masks.....	367
Figure 252. Mask Image dialog box	368
Figure 253. Match Images dialog box	371
Figure 254. Additive Noise dialog box	372
Figure 255. Examples of adding noise to an image and using it to test an algorithm's effectiveness in removing the noise	374
Figure 256. Original image to be rotated	375
Figure 257. Rotation.....	376
Figure 258. Examples of rotated images.....	377
Figure 259. Remove Slices dialog box.....	379
Figure 260. Using the image slider to look through an image dataset.....	381
Figure 261. The Utilities > RGB menu	383
Figure 262. RGB -> Gray dialog box	384
Figure 263. Manually converting RGB datasets to grayscale	386
Figure 264. Example of three grayscale datasets generated automatically from an RGB dataset	387
Figure 265. Original image before subsampling.....	388
Figure 266. Subsample dialog box	389
Figure 267. An image subsampled by 2, by 4, and then by 8	390
Figure 268. Progress message for swapping the third and fourth dimension	391
Figure 269. MIPAV Options dialog box with Show scripting toolbar selected ..	393
Figure 270. The MIPAV window (A) before selecting a scripts home and (B) after selecting a scripts home and running the first script.....	394
Figure 271. An (A) active image, whose title bar is highlighted, and (B) inactive image, whose title bar is dimmed.....	395

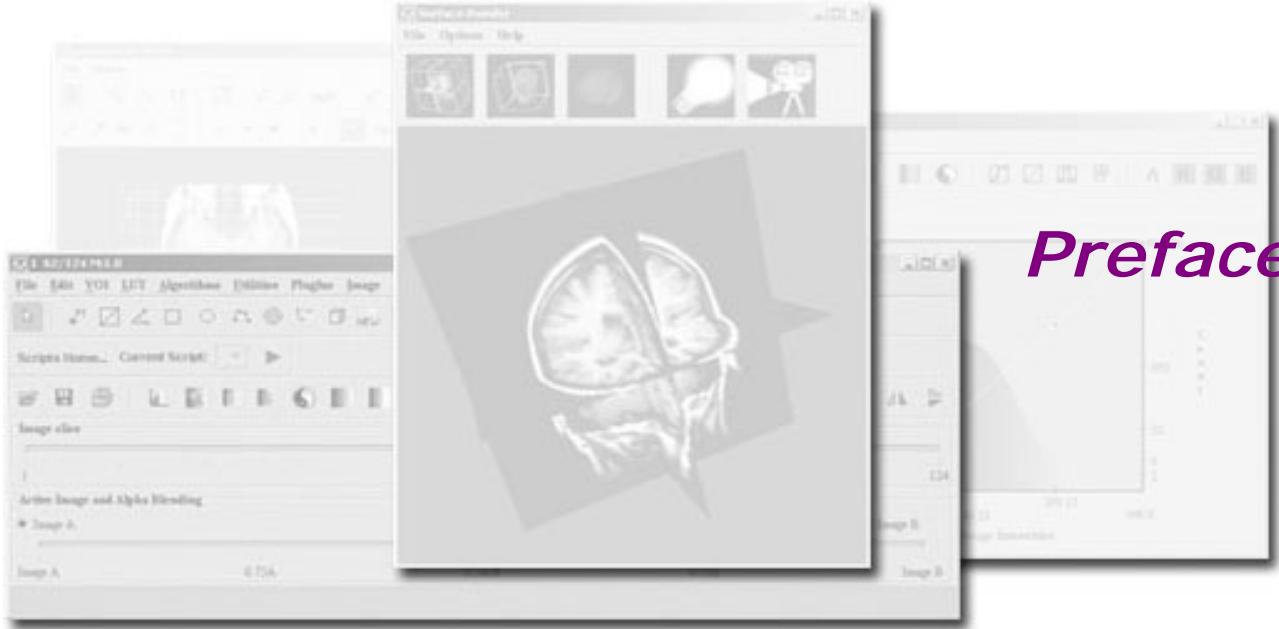
Figure 272. A comparison of (A) the initial scripting toolbar and (B) the toolbar as it looks after you identify a scripts home and run your first script	396
Figure 273. Choose Directory dialog box	397
Figure 274. Record New Script dialog box.....	398
Figure 275. The (A) Record New Script dialog box and (B) the scripting dialog box after opening an image in group mode.....	400
Figure 276. Run Script on Multiple Images dialog box	404
Figure 277. Run Script on Multiple Images dialog box (image and VOI selection)	
405	
Figure 278. Record New Script dialog box (A) before and (B) after clicking Enable Edit	407
Figure 279. Open dialog box showing scripts in the scripts home directory	408
Figure 280. Command Prompt dialog box showing command to open Command Line Help dialog box.....	410
Figure 281. Command Line Help dialog box, which shows the syntax of the mipav command as well as examples.....	410
Figure 282. MIPAV dataflow diagram	417



List of Tables

Table 1. File formats	22
Table 2. Graphics file formats supported by MIPAV.....	95
Table 3. Data types supported by MIPAV.....	105
Table 4. Standard tasks provided through commands on the Utilities menu in the MIPAV window.....	338
Table 5. Solutions for correct image spacing.....	354
Table 6. DICOM query, retrieve, and sender classes supported by MIPAV	422
Table 7. Verification and DICOM receiver classes supported by MIPAV	423
Table 8. Supported C-FIND SOP class	423
Table 9. Presentation context proposed by MIPAV as a result of real-world activity query request to an external query server	425
Table 10. DICOM data elements supported for SOP class study root query/ retrieve information model C-FIND SCU"	425
Table 11. Supported image storage service	426
Table 12. Presentation context proposed by MIPAV as a result of real-world activity "MOVE Request to an External Query Server"	427
Table 13. DICOM data elements supported for SOP Class Study Root Query/ Retrieve Information Model C-MOVE SCU	428

Table 14. Supported C-STORE SOP classes	429
Table 15. Presentation contexts proposed by MIPAV as a result of real-world activity “store request to an external query server	430
Table 16. Supported verification SOP class.....	431
Table 17. Presentation contexts accepted by MIPAV as a result of real-world activity “verification” equest	433
Table 18. Supported C-STORE SOP classes	433
Table 19. Presentation contexts proposed by MIPAV as a result of real-world activity “receive and store images”	435
Table 20. DICOM tags	438



Preface

The purpose of the MIPAV software program is to allow medical researchers to extract quantitative information from image datasets of various medical image modalities.

Scope of this guide

The primary purpose of the *MIPAV User's Guide* is to provide medical researchers the information they need to use the MIPAV software program.

A secondary goal is to give researchers the information needed to extend, if desired, the software's capabilities through the development of new functions in plug-in applications via use of the software's application program interface (API).

Who should use this guide

Medical researchers, medical technicians, and other people who are involved in analyzing medical images or maintaining and supporting the equipment used to produce images form the audience for the *User's Guide*.

Skills you need to perform tasks in MIPAV

Depending on the platform—Windows, MacIntosh, or Unix—that is running your workstation, it is recommended that you are familiar with installing and using software programs for that platform.

If you plan to create plug-in applications for MIPAV to add new functionality, you must have software programming skills and be familiar with Java.

How this guide is organized

The *MIPAV User's Guide* is divided into two volumes:

- Volume 1, *Basics*, explains how to use the basic features and functions of MIPAV and how to incorporate plug-in applications.
- Volume 2, *Algorithms*, presents detailed information about the purpose, background, and function of the algorithms packaged with MIPAV and gives instructions for using them.

Volume 1, Basics

The *MIPAV User's Guide*, Volume 1, *Basics*, includes the following:

- Chapter 1, “Introducing MIPAV,” presents an overview of the MIPAV software program.
- Chapter 2, “Installing MIPAV,” explains how to install, remove, and upgrade the MIPAV software program. It also explains how to subscribe to the MIPAV mail list and how to search the MIPAV archive.
- Chapter 3, “Getting Started Quickly with MIPAV,” explains how to use MIPAV to perform common functions, such as opening an image file, saving the file, and printing a log file.
- Chapter 4, “Understanding Image Basics,” lists the file formats supported by MIPAV and provides background information on image file formats. It also provides information on how to view and adjust image file attributes.

- Chapter 5, “Working with DICOM Images,” explains how to access DICOM databases, perform queries, and retrieve image files. In addition, it explains how to send files to a database.
- Chapter 6, “Visualizing Images,” provides instruction on how to customize the way image files are displayed, how to magnify and minify images, how to view images together, how to view a portion of the image, and how to change image brightness and contrast by generating histograms and adjusting color look-up tables (LUTs).
- Chapter 7, “Segmenting Images Using Contours and Masks,” explains how to create, group, rearrange, and modify volumes of interest (VOIs); how to create masks; and how to use paint to further identify VOIs.
- Chapter 8, “Analyzing Images,” discusses how to calculate statistics for VOIs and masks and how to generate intensity profiles, or graphs, for images.
- Chapter 9, “Changing Image Datasets Using MIPAV Utilities,” explains how to use the utilities included in the software.
- Chapter 10, “Developing Plug-in Programs,” explains how to incorporate plug-in programs into MIPAV.
- Appendix A, “DICOM Conformance Statement,” provides a copy of the formal DICOM Conformance Statement, which specifies MIPAV’s service classes, information objects, communications protocols, and media storage application profiles.
- Appendix B, “Technical Information,” provides examples of files MIPAV system files (such as the preference file) and explains how the user can interpret them; provides limited instruction on how to modify specific files. Also explains how to use the debug mode.
- Appendix C, “Toolbar Buttons,” displays the buttons on the Image, Paint, and VOI toolbars and provides a short description of the function of each button.
- Appendix D, “Reference,” provides a list of references that can be used to learn more about MIPAV functions.

The guide also includes a glossary of terms and acronyms.

Volume 2, Algorithms

Volume 2, *Algorithms*, includes two chapters:

- Chapter 1, “MIPAV Algorithms Overview,” which discusses the tools and application programming interface provided with MIPAV
- Chapter 2, “Using MIPAV Algorithms,” provides detailed information about the algorithms packaged in MIPAV

In addition, the book includes the glossary of terms and acronyms.

Where to find more information

Both volumes 1 and 2 of the *MIPAV User’s Guide* are available as Acrobat PDF files, which you can view, download, and print. You can either print each volume, or you can print individual chapters separately. For PDFs of this guide, go to the MIPAV web site:

<http://mipav.cit.nih.gov/guide.htm>

Conventions used in this guide

This guide uses the following conventions:

This convention . . .	Stands for . . .
<i>Italics</i>	Names of books, guides, or manuals as references New terms or emphasis Names of executable files
Bold	User input Names of programming commands
All caps	File types, such as TIFF, GIF, or JPG
Upper- and lowercase	Names of keys
name@address.com	E-mail address format
<u>Hyperlink</u>	An internet link (position the cursor on this word and click the left mouse button)*
Monospace	Code sample, including keywords and variables within text and as separate paragraphs, and user-defined program elements within text

*All figure and table citations, such as Figure 1 or Table 1, are hyperlinks although they are not underscored. Clicking the citation displays the appropriate figure or table.

Both volumes of the *MIPAV User's Guide* include special information that briefly highlights particular features or functions or that provide clarification. Based on the type of information they convey, these notes are labeled "note," "tip," "example," "recommendation," "remember," "reference," "caution," and "disclaimer." The following examples indicate how these notes appear and the type of information they include.



Note: Notes provide additional information that is related to the subject at hand. They tend to be "by the way" types of information or asides.



Tip: Tip paragraphs point out application shortcuts or briefly describe special features of the software.



Example: An example paragraph provides an example of a task or incident in which something of note could occur.



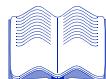
Recommendation: Paragraphs that are labeled "Recommendation" suggest methods of good practice or advice.



Definition: The definitions of specific words or phrases of note appear in "definition" paragraphs.



Remember: Notes labeled "Remember" present information that was previously discussed and that is pertinent in the current topic.



Reference: A reference note highlights one or more references that contain information on the current topic.



Caution: A paragraph labeled "Caution," alerts you to be very careful about avoiding some action that could harm your equipment or data.



Disclaimer: A disclaimer indicates the possible limitations or ramifications of a topic.